University of Rhode Island Department of Electrical and Computer Engineering
ELE 435: Communication Systems

FM MATLAB assignment

1. Matlab Code

   (a) Modulation: Generation of an FM signal:

      i. Generate an FM signal, given by $s(nT_s) = A_c Cos((2\pi f_1 nT_s) + \beta sin(2\pi f_2 nT_s))$, where $A_c = 2$, $f_1 = 20KHz$, $f_2 = 200Hz$, $T_s = \frac{1}{f_s}$, $f_s = 80KHz$, and vary β for example 0.2, 1, 5 etc.

      ii. Plot the spectrum for atleast two different values in the report. You may want to run for few other values to get an idea. The Plots should look like Figure 5-11, Page 327 in the text book. There might be a scaling factor difference in the plots, for now you can ignore that.

   (b) Demodulation: Build an FM receiver (demodulator) using Hilbert Transform

      i. Take the Hilbert transform of the above generated FM signal, the result is $c(nT_s) = e^{((2\pi f_1 nT_s)+\beta sin(2\pi f_2 nT_s))}$. Use the hilbert command in matlab.

      ii. Take the conjugate of the Hilbert transform.

      iii. Plot the angle of result generated by $c(nT_s)c^*((n-1)T_s)$, where $c^*((n-1)T_s)$ is the conjugate of hilbert and is also shifted by one sample.

   (c) Design a Low Pass Filter and Band Pass Filter for different Filter orders. Show plots for Orders 10 and 100. Use freqz command in MATLAB to see the characteristics. You may want to run for few more filter order values and cut-off frequency values gives below to see the filter characteristics.

   (d) MATLAB Help:

      i. To design a Low Pass filter: b = fir1(filterorder,$f_c/(f_s/2)$), where $f_c/(f_s/2)$ is called the normalized cut-off frequency

      ii. To design a Band Pass filter: b = fir1(filterorder,[$f_{b1}/(f_s/2)$ $f_{b2}/(f_s/2)$])

      iii. To check the characteristics: Try freqz(b,1,512)

      iv. Parameters: $f_c = 10$ KHz, $f_{b1} = 6$KHz, $f_{b2} = 12$K, $f_s = 40$ KHz,

   (e) JUSTIFY/Comment on the matlab commands you used in the code to obtain credit.